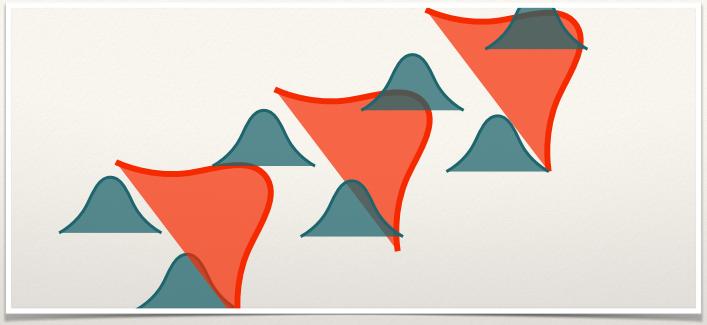
Modeling inter- and intra- speaker variance in sound change



Modeling inter- and intra-speaker variance in sound change

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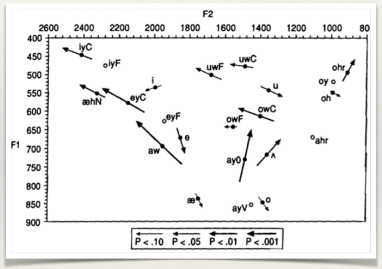
THE UNIVERSITY of EDINBURGH
School of Philosophy, Psychology and Language Sciences

The Dynamics of Sound Change

The study of vowel shifts has largely focused on shifts in the *average* value of vowels in the Hz space.

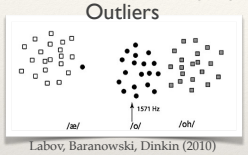


Labov (2001)

The Dynamics of Sound Change

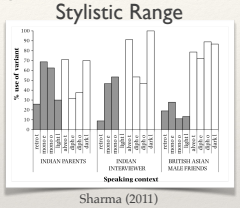
But other distributional properties have always been of some interest.

Outliers



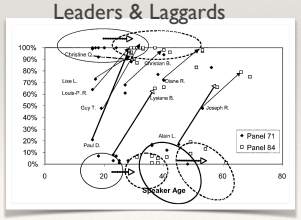
Labov, Baranowski, Dinkin (2010)

Stylistic Range

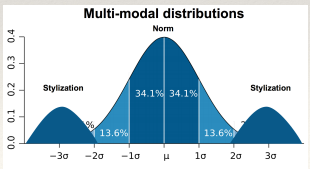


Sharma (2011)

Leaders & Laggards



Sankoff & Blondeau (2007)



Van Hofwegen (2015)

The Dynamics of Sound Change

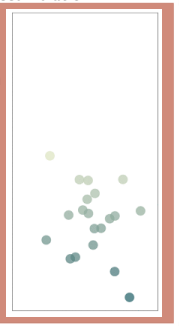
They play an important role in sound change theory more broadly.

Error Accumulation

One Speaker's Representation

Ohala (1981, among others)

Maximal variance at midpoint of change.



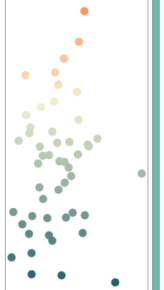
Convergence Model

Speakers in a Community

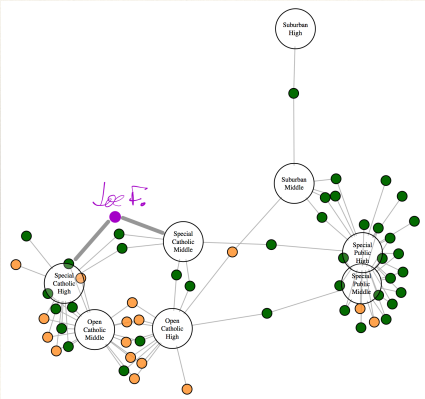
Baker et al (2011)

Blevins (2004)

Maximal variance at start of change.



Language Change Diffusion



Sneller (2018) on the diffusion of a contact induced change through educational institutions in Philadelphia.

Looking at Variance

```
Linear mixed model fit by REML ['lmerMod']
Formula: F1_n ~ dob0 * gender + (1 | idstring) + (1 | word)
   Data: ay0

REML criterion at convergence: 28507.4

Scaled residuals:
    Min      1Q  Median      3Q     Max
-5.8493 -0.5978 -0.0393  0.5484  9.6440

Random effects:
 Groups   Name        Variance Std.Dev.
 idstring (Intercept) 0.03032  0.1741
 word     (Intercept) 0.07577  0.2753
 Residual             0.24297  0.4929
Number of obs: 19383, groups:  idstring, 325; word, 270

Fixed effects:
             Estimate Std. Error t value
(Intercept)   1.5103124  0.0444196   34.00
dob0         -0.0131445  0.0006282  -20.93
genderm      -0.1340959  0.0585211   -2.29
dob0:genderm  0.0017686  0.0009462    1.87
```

- Standard LMEs allow you to look at variance *a little bit*.

Estimated standard deviation *between* speaker averages.

Does not co-vary with any other parameter…

Estimated standard deviation *within* all speakers.

Only one parameter for *all*, speakers. Does not covary with any other parameter…

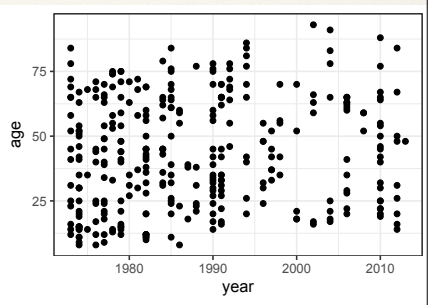
In this talk

Philadelphia

- 6th largest city in America
- ~1.5 million people.
- Peak population: 2 million in the 1950s
- Racial&Ethnic Demo:
  - 43% African American
  - 41% White
  - 13% Latino
  - 6% Asian

In this talk

Automatically extracted formant values using the FAVE-suite from 326 White speakers interviewed between 1973 and 2013 in the Philadelphia Neighborhood Corpus.



In this talk

I'll be examining these two sound changes in Philadelphia.

/ay/
Conditioned Sound Change
[ayT] — Raised
[ayD] — Stayed the same

/aw/
Strong gender effects
women — led and then reversed
men — lagged behind

Predictions:

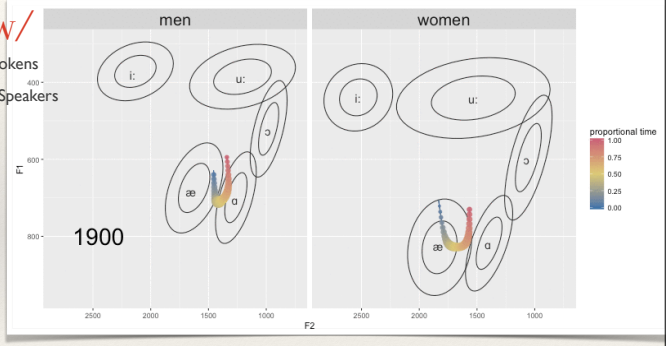
Both the error accumulation model and the convergence model predict changes in variance parameters relative to the change.

This could be especially true for more innovative groups.

Comparison can be made to non-changing vowels.

The Sound Changes

/aw/
6,720 tokens
321 PNC Speakers

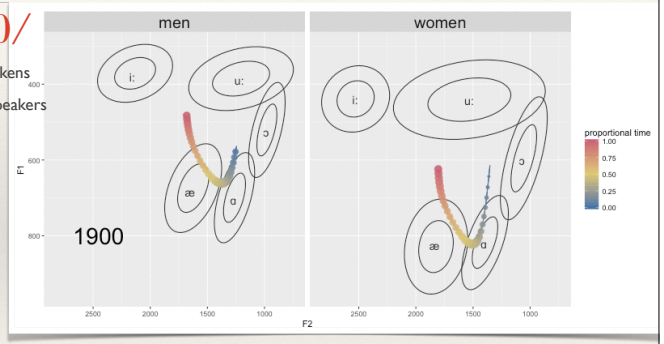


Jane, DOB 1939

Jane, DOB 1992

The Sound Changes

/ay0/
19,383 tokens
325 PNC Speakers



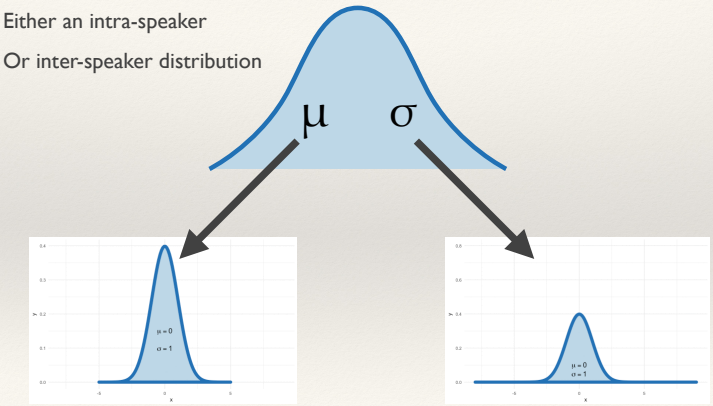
Laurel, DOB 1905

Amy, DOB 1984

The Model

Either an intra-speaker

Or inter-speaker distribution



The Model

"Autoregression"

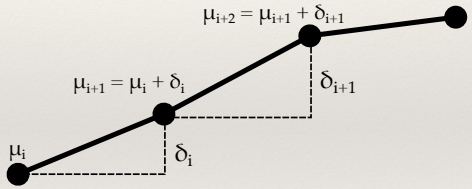
μ_i = the estimated mean for each year of birth

δ_i = the difference from the prior year

If $\delta_i = 0$, no change

If $\delta_i > 0$, increase

If $\delta_i < 0$, decrease



$\delta_i \sim \text{normal}(\delta_{i-1}, \sigma)$

The Model

"Autoregression"

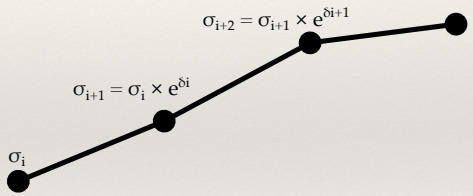
σ_i = the estimated variance

$e^{\delta i}$ = how many times the previous year

If $\delta_i = 0$, no change

If $\delta_i > 0$, increase

If $\delta_i < 0$, decrease



$\delta_i \sim \text{normal}(\delta_{i-1}, \sigma)$

The Models

It's too complex to model both intra-speaker and inter-speaker variances using an AR process at the same time.

Within-Speaker Model

- Within speaker variances are estimated as an AR process, and can vary over DOB
- Between speaker variances are estimated from a fixed prior

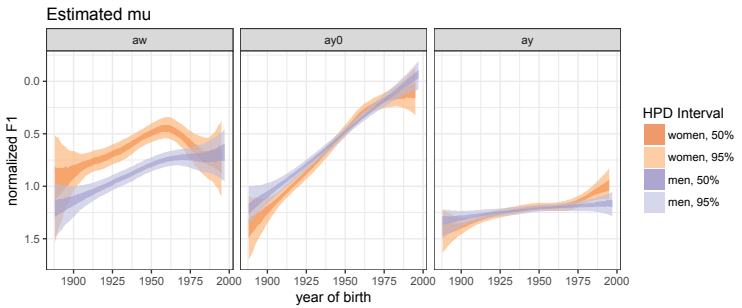
Between-Speaker Model

- Within speaker variances are estimated from a fixed prior.
- Between speaker variances are estimated as an AR process and can vary over DOB

Both models:

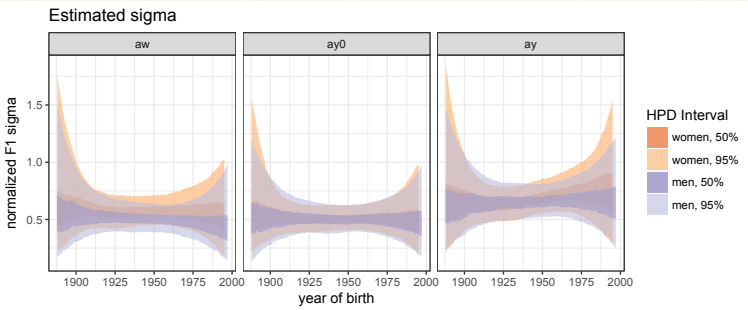
The estimated average for DOB cohorts is estimated as an AR process.
Random intercepts by word

Within Speaker Results



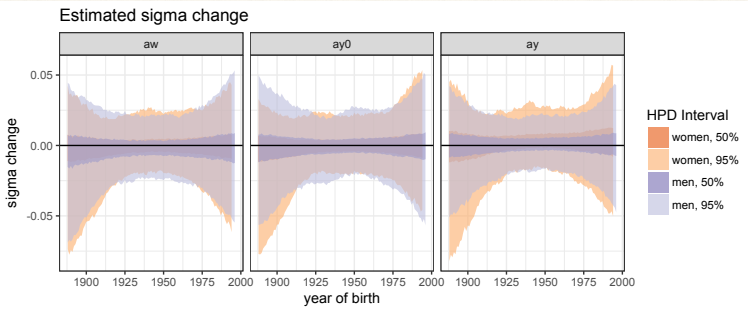
These results look exactly like all previous models of these changes.

Within Speaker Results



[ay] (the non-changing vowel) has a slightly larger within-speaker variance than the changing vowels. No reliable DOB or gender effects on variance.

Within Speaker Results

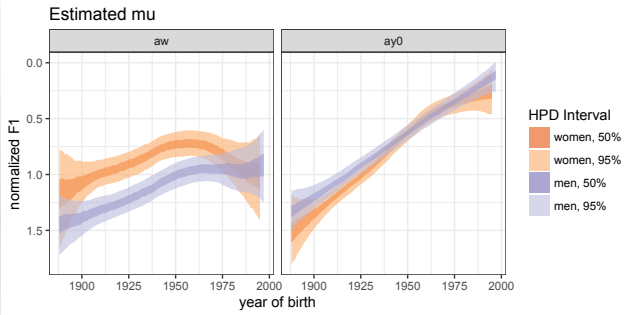


Estimated variance change parameter is 0 at all time points.

Within speaker conclusions

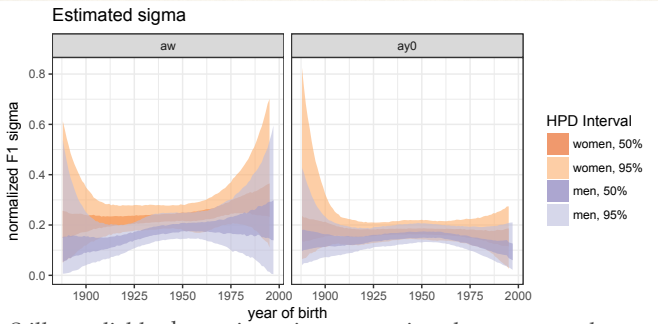
- No reliable changes in within-speaker variance over time *despite* the dramatic change in means.
- No reliable gender effects.

Between Speaker Results



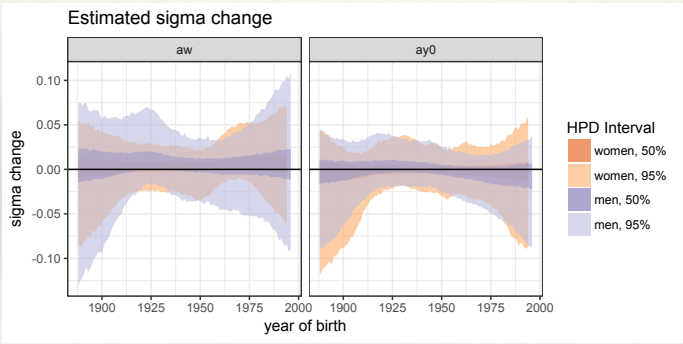
Broadly similar results for the location parameter ([ay] missing due to #ASOS).

Between Speaker Results



Still no reliable change in variance over time, but some weak evidence for a gender effect (larger between-speaker variance for women).

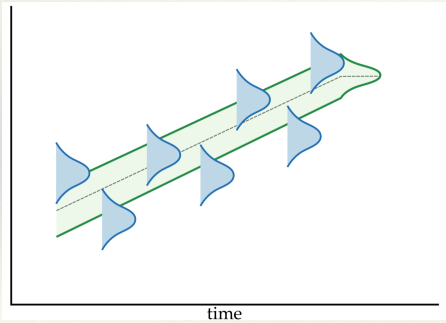
Between Speaker Results



Between-speaker conclusions

- Some weak evidence for variance within women to be slightly larger than between men.
- No dynamic changes across the sound change.

The emerging picture



A general model of sound change that explicitly or implicitly assumes changes in within or between speaker variances is not well supported by this data.